CEMENT MILL SECTION of

Concrete

The Cement Mill Edition of Concrete is edited exclusively for those interested in the manufacture of portland cement. Its pages are devoted to discussions of plant design, management, operation, production efficiency, chemical research and control, quarry operation, progress and news of the industry.

The Cement Mill Edition also contains all the material published in the corresponding Regular Edition and so provides news of the uses and merchandising of the materials whose manufacture is discussed in the Mill Edition. The Regular Section furnishes mill operating officials and mill executives valuable points of contact with the users of the materials they produce.

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Investigation of Clinkering Zone in a Rotary Kiln

Analytical and X-Ray Methods Utilized in Study of Alit in Coating on Wall of Kiln — Properties of This Constituent

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THE analytical and X-ray determination of the Alit in clinker offers considerable difficulty, because it is almost impossible to separate the Alit from the other mineral constituents in the clinker. A few investigators have accomplished isolation through centrifugal action on the finely ground clinker, through liquation by means of light eutectic fusing, which generally succeeds. Through these preparations the composition of the Alit is then determined.

Previous Investigations of Alit

Le Chatelier[1] separated tricalcium silicate from the other mineral constituents of the clinker. Tornebohm[2] identified Alit as an isomorphic mixture of tricalcium silicate and calcium aluminate. Rankin and Wright,[3] Bates,[4] Bates and Klein,[5] and others, found in cements fixed tricalcium silicate ($3CaO.SiO_2$) and the high-lime aluminates $3CaO.Al_2O_3$ and $5CaO.3Al_2O_3$. Richardson[6] expressed the opinion that Tornebohm's Alit is a solid solution of tricalcium aluminate ($3CaO.Al_2O_3$) in tricalcium silicate ($3CaO.SiO_2$). Hansen and Brownmiller,[7] and later Weyer,[8] showed X-ray diagrams of tricalcium silicate and of synthetic clinker, which pointed toward fixed tricalcium silicate. Campbell[9] obtained, during the liquation of clinker between magnesium plates, a clear residue, which when analyzed was found to contain 90.23 per cent of $3CaO.SiO_2$ and 10.48 per cent of $5CaO.3Al_2O_3$. Unfortunately no optical identification was obtained. Guttmann[10] determined from a rational analysis of clinker from a rotary kiln that Alit contained 68.5 per cent of $3CaO.SiO_2$ and 21.4 per cent of $3CaO.Al_2O_3$.

Isolated in Crystal Form

Of particular interest are the investigations of Guttmann and Gille.[11] They examined some high-alumina clay for the essential constituent Alit, and isolated it in crystal form, in a series of mixtures of tricalcium silicate with tricalcium aluminate, and obtained a substance closely approaching tricalcium silicate. One year later, however, they found a basis for experiments with Alit, which was isolated from synthetic clinker, as it consists mainly of tricalcium silicate ($3CaO.SiO_2$). The tricalcium aluminate ($3CaO.Al_2O_3$) was believed to play only a subordinate role. In their latest work[12] they also hold to this view, and declare the existence of Alit on the basis of their optical analysis and analytical X-ray photographs of pure tricalcium silicate. They lean definitely away from the views of Dyckerhoff,[13] Kuhl[14] and Janecke.[15] The Al_2O_3 appears as the essential constituent of Celit ($4CaO.Al_2O_3.Fe_2O_3$), while the remainder appears in the $3CaO.Al_2O_3$ and the $5CaO.3Al_2O_3$. If Alit is pure $3CaO.SiO_2$, it is, in consequence, necessary to assume that the aluminate—always reported present by other investigators, such as Le Chatelier, Tornebohm, O. Schmidt[16] and Campbell—is an outgrowth from the tricalcium silicate. J. Weyer[17] has occupied himself with the question of mixed crystal structures, by means of the X-ray method. Likewise, Brownmiller and Bogue[18] were able to offer evidence of a mixed crystal formation.

Samples from Coating on Wall of Kiln

Up to the present time we have evidence that Alit consists of pure tricalcium silicate, and that mixed crystals can not be obtained from $3CaO.SiO_2$ having a small content of $3CaO.Al_2O_3$. Also the complete determination as well as the refraction indices and the optical characteristics of the tricalcium silicates and of the Alits can not be proved, as the refraction index of $3CaO.Al_2O_3$ is of the same order of magnitude. A mixed crystal structure of symmetrical crystals is possible (isodimorphous).

On this question the present investigation provides further material. A series of experimental burnings are being conducted in a short rotary kiln having magnesia brick lining, with normal raw meal and the addition of fluorspar, but under higher than normal temperatures.

Nature of Coating

Parallel to the surface of the kiln wall are different color zones. Some whitish, some greenish and some dark portions are easily recognized. The easily fused part of the clinker is also seen toward the outside (that is, toward the kiln wall), in liquefied form. Thin microscopic sections taken perpendicular to the layer formations of the coating on the kiln wall are shown in Figures 1 and 2, and these are clearly of a granular structure. In the light-colored part lie the individual crystals in direct juxtaposition, inlaid in a granular slag-like mass, while in the dark part they are imbedded in the dark-colored ground mass. The idiomorphous formation of the crystals is clearly defined in the dark-colored portion. The crystals are partly elongated, partly of flat or plate-like structure, and may well belong to the monoclinic or rhombic system, although the flat crystals appear to have a hexagonal shape. The prismatic crystals have a somewhat higher double refraction than the flat crystals. The crystals are too small for goniometric-crystallographic measurement.

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[1] Le Chatelier, *Ann. des Min.* 1887 II. p. 345. Experimental investigations of the constitution of hydraulic mortars.

[2] Tornebohm, The Petrography of Portland Cements, Stockholm, 1897.

[3] G. A. Rankin, *Jour. Ind. Eng. Chem.* 7, 1915, p. 466.

[4] P. H. Bates, *Zement*, 1913, p. 76.

[5] P. H. Bates and A. A. Klein, Technologic Papers of the U. S. Bureau of Standards, No. 43, 1914.

[6] Clifford Richardson, *Zement*, No. 4, 1903, p. 276; No. 5, 1904, p. 40; No. 6, 1905, p. 18.

[7] Hansen and Brownmiller, *Jour. Am. Ceramic Soc.*, Vol. 11, 1928.

[8] J. Weyer, Diss. Kiel, 1930.

[9] Campbell, *Tonindustrie Zeit.* No. 38, 1914; No. 150, p. 1891; No. 152, p. 1902.

[10] A. Guttmann, *Stahl u. Eisen*, 1924 III., pp. 786-815.

[11] Guttmann and Gille, *Zement*, Nos. 39 and 40, 1927; No. 8, 1928.

[12] Guttmann and Gille, *Zement*, No. 7, 1931.

[13] W. Dyckerhoff, Diss. Frankfurt a. M. 1925.

[14] H. Kuhl, Zementchemie in Theorie und Praxis, Berlin, 1929.

[15] Janecke: Protokoll, 1928.

[16] O. Schmidt, Der Portlandzement, Stuttgart, 1906.

[17] J. Weyer, *Zement*, No. 5, 1931.

[18] Brownmiller and Bogue, *Amer. Jour. Sci.* V Ser. Vol. XX, No. 118 (1930).

The Optical Analysis

For the optical analysis the whitish portion was now removed from the particles of clinker and placed under the binocular microscope, having been carefully separated from the slightly darkened portion. The optical analysis gave for the refraction indices the following values: $\alpha = 1.717$ plus or minus 0.003; $\gamma = 1.722$ plus or minus 0.003. The value of β could not be determined. The double refraction varied. The optical character was negative. The crystals are bi-axial. The data are identical with those obtained with tricalcium silicates and are in accord with those given out by Guttmann and Gille, and by Weyer. The chemical analysis, made by Dr. M. Bendig, to whom grateful acknowledgment is due, was conducted with special care and gave the following results:

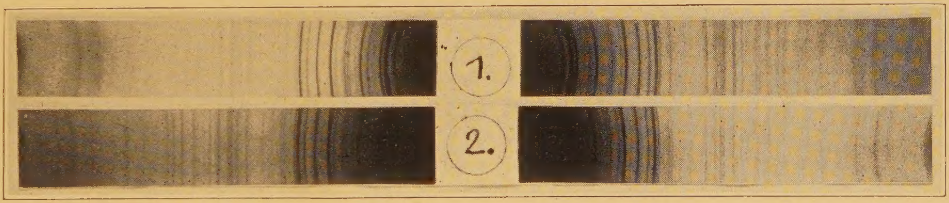


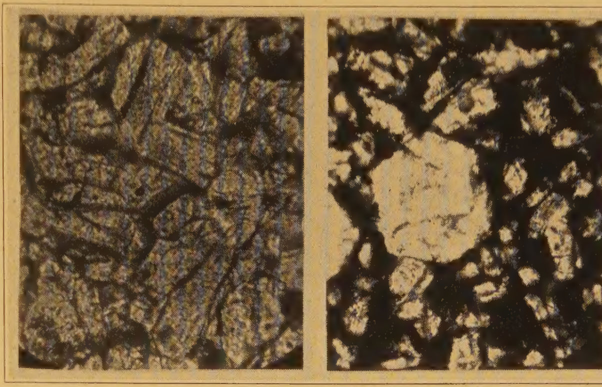
Figure 3. X-ray diagram, showing (1) a mechanical mixture of 96 per cent $3CaO.SiO_2$ and 4 per cent $3CaO.Al_2O_3$, and (2) the light colored Alit clinkers

	Per Cent		Per Cent
SiO_2	23.03	MgO	2.18
Al_2O_3	1.70	K_2O	0.02
TiO_2	0.14	Na_2O	0.35
Fe_2O_3	0.12	H_2O	0.35
MnO	0.05	SO_3	0.82
CaO	70.43	F	1.56

Determination of the mineral components of the clinker disclosed the following percentages:

3.20% CaF_2, with 2.3% combined lime.
1.39% $CaSO_4$, with 0.57% combined lime.
87.53% $3CaO.Si_2$, with 64.50% combined lime.
4.51% $3CaO.Al_2O_3$, with 2.81% combined lime.
—Total combined lime (CaO) = 70.18 per cent.

The four mineral constituents have a total of 70.18 per cent of combined lime, as against a total lime content of 70.43 per cent determined from the chemical analysis. The difference of 0.25 per cent may be neglected. No free lime was found by the Emley method. Above all was the fact that in the white portion of the layer formations on the kiln wall at the clinkering zone a crystalline structure was formed, which has the optical constants of tricalcium silicates; however, according to the chemical analysis it contains tricalcium silicate.



Figures 1 and 2, magnified 90 times. Figure 1 (at left) shows Alit in the light-colored part of the clinker. Figure 2 (at right) shows Alit in the dark part of the clinker

Preparation for X-Ray Analysis

For the X-ray analysis a sample was carefully pulverized, mixed with resin and then drawn out to a fine thread of 0.3 mm. diameter. The photographs were taken with a camera of 57.3 mm. diameter, with CuK radiation, which was filtered through a nickel-and-aluminum screen or foil. In Table 1 are the calculated values of *d* for the whitish clinkers and for a mixture of 96 per cent $3CaO.SiO_2$ and 4 per cent $3CaO.Al_2O_3$. In the X-ray diagrams in Figure 3, the one showing the Alit clinker shows wider, though very weak, lines alongside the lines of $3CaO.SiO_2$. Moreover, observe in particular the low intensity variation opposite the pure $3CaO.SiO_3$. The clinker is shown to contain small quantities of impure substances. Thus the intensity of lines No. 12 and No. 23 show clearly the presence of calcium fluoride (CaF_2), although the presence of magnesium oxide (MgO), in consequence of the smaller concentration, can not be definitely distinguished. Lines 16 and 21 show interference with (220) and (113) of the CaO identification. However, because of the special strength of line (200) of the CaO, proof of the presence of free lime is not capable of demonstration. Any other explanation of lines 16 and 21, as well as line No. 2, can not be given for the present. The characteristic lines of $3CaO.Al_2O_3$ and those of $5CaO.3Al_2O_3$ do not stand out.

There is the possibility that a small content of around 4.5 per cent of $3CaO.Al_2O_3$ lying below the limit of perceptibility of the photographic process was identical with

TABLE 1

Evaluation of the X-Ray Diagrams

	(1) Mechanical mixture of 96 per cent $3CaO.SiO_2$ and 4 per cent $3CaO.Al_2O_3$.		(2) White clinker from coating on kiln wall in clinkering zone.	
Number	Value of *d*	Intensity	Value of *d*	Intensity
1	3.89	s.s.	3.89	s.s.
2	------	------	3.57	s.s.s.
3	3.03	st.	3.03	st.
4	2.76	s.st.	2.76	s.st.
5	2.60	st.	2.60	st.
6	2.44	s.s.	2.44	s.
7	2.31	s.	2.31	m.
8	2.25	s.s.s.	------	------
9	2.18	st.	2.18	st.
10	2.09	s.s.	2.08	s.
11	1.982	s.s.	1.973	s.s.
12	1.932	s.	1.928	s.
13*	1.897	s.s.	------	------
14	1.824	s.s.	1.829	s.
15	1.762	st.	1.762	st.
16	------	------	1.693	s.s.
17	1.631	st.	1.624	m.st.
18	1.542	m.	1.539	m.
19	1.490	st.	1.488	st.
20	1.460	s.s.	1.456	s.
21	------	------	1.427	s.s.
22	1.392	s.	1.388	s.s.
23	1.369	s.s.s.	1.369	s.
24	------	------	1.346	s.s.s.
25	1.324	s.s.s.	1.323	s.s.
26	1.307	s.s.s.	1.299	s.s.
27	1.274	s.s.s.	1.268	s.s.
28**	1.207	s.s.s.	------	------
29	1.197	s.	1.194	s.
30	1.165	s.	1.166	s.
31	1.149	s.s.	1.157	s.
32	1.141	s.s.	1.136	s.
33	1.128	s.	1.124	s.
34	1.093	m.	1.089	s.
35	1.067	s.	1.063	s.
36	1.053	s.s.	------	------
37	1.044	s.s.	1.036	s.s.
38	1.028	s.s.	1.027	s.s.
39	1.014	s.s.	1.018	s.

*(400) of $3CaO.Al_2O_3$ (according to Harrington).

**(260) of $3CaO.Al_2O_3$ (according to Harrington).

The accuracy of the values of *d* range, according to the intensity, from 3 to 5 per cent.

that of the 4 per cent of $3CaO.Al_2O_3$ mixed with the pure $3CaO.SiO_2$ shown in Figure 3. In contrast to the data given out by J. Weyer, the 6.89 per cent of $3CaO.Al_2O_3$ no longer can be shown. The characteristics do not agree with the principal lines of the $3CaO.SiO_2$. In Figure 4 is the photometric diagram of a line-group in the vicinity of line No. (400) of the $3CaO.Al_2O_3$ reproduction (taken from Harrington). It is seen that line (400) appears with noticeable intensity in the mixture of 96 per cent $3CaO.SiO_2$ and 4 per cent $3CaO.Al_2O_3$, whereas in the whitish clinker it does not exist.

Now in the X-ray diagram the Alits do not appear in the lines of $3CaO.Al_2O_3$ in the mixture of 96 per cent $3CaO.SiO_2$ and 4 per cent $3CaO.Al._2O_3$, so it is probable that there exists a mixed crystal formation of small quantities of $3CaO.Al_2O_3$ in $3CaO.SiO_2$. In support of this view the mechanical mixture was heated at 1,380 deg. C. for a period of 15 hours. The new photographs of these samples show without question that the lines of $3CaO.Al_2O_3$ had disappeared. With a greater content of $3CaO.Al_2O_3$ these crystals appear, as Guttmann and Gille have also shown.

Plans for Further Research

For the further defining of the mixed crystallization between $3CaO.SiO_2$ and the aluminates $3CaO.Al_2O_3$ and $5CaO.3Al_2O_3$ we have inaugurated further research, which will be reported later.

Analyses Compared

One may now compare the analyses of both the de-acidified raw meals utilized in the tests, as follows:

	Per Cent		Per Cent
(1) SiO_2	21.51	(2) SiO_2	23.26
Al_2O_3	5.65	Al_2O_3	6.05
Fe_2O_3	2.83	Fe_2O_3	3.10
CaO	66.40	CaO	63.57
MgO	2.51	MgO	2.79
Undet.	1.09	Undet.	1.24

Then the foregoing analyses may be compared with the analysis of the whitish portion of the coating or layer formations on the kiln wall of the clinkering zone, from which it develops that the Fe_2O_3 is almost completely liquefied. However, the Al_2O_3 content has been decreased. Both portions must consequently have originated in the dark portion of the clinkering zone coating. For proof there were taken from the white portion two samples for analysis. The analytical values were:

	Per Cent		Per Cent
(1) SiO_2	21.32	(2) SiO_2	20.40
Al_2O_3	4.46	Al_2O_3	5.10
Fe_2O_3	2.37	Fe_2O_3	3.00
CaO	68.33	CaO	67.00
MgO	1.95	MgO	2.43
Undet.	0.54	Undet.	0.28

These figures permit the composition of the mineral constituents of the clinker to be calculated. The microscopic examination of the thin sections (Figures 1 and 2) discloses that the light-colored crystals are similar to those in the whitish portion of the clinkers, and that they also consist of $3CaO.SiO_2$ and $3CaO.Al_2O_3$.

Calculation of Mineral Constituents

The calculations are carried through on the following basis: The silica (SiO_2) is combined as $3CaO.SiO_2$, the iron oxide (Fe_2O_3) is combined as tetracalcium alumino-ferrite ($4CaO.Al_2O_3.Fe_2O_3$), and the remaining aluminum oxide (Al_2O_3) is combined as $3CaO.Al_2O_3$.

The calculation of the mineral components results, from sample No. (1) above:

81.03 per cent $3CaO.SiO_2$
7.00 per cent $3CaO.Al_2O_3$
7.21 per cent $4CaO.Al_2O_3.Fe_2O_3$

Here no less than 67.9 per cent of the lime (CaO) becomes combined, according to the calculations, while according to the quantitative analysis a lime content of 68.33 per cent compares with this figure.

From the analysis of sample No. (2) the calculation of the mineral components gives the following results:

77.53 per cent $3CaO.SiO_2$
8.43 per cent $3CaO.Al_2O_3$
9.13 per cent $4CaO.Al_2O_3.Fe_2O_3$.

In this case we have a total calculated combined lime (CaO) content of 66.7 per cent, compared with 67.0 per cent found by means of the quantitative analysis.

From both the foregoing calculations the chemical analyses are proved correct, so that one may assume in these cases that the CaO is found in the three combinations $3CaO.SiO_2$, $3CaO.Al_2O_3$ and $4CaO.Al_2O_3.Fe_2O_3$, and that the Fe_2O_3 is found as tetracalcium alumino-ferrite in the cooler portions of the clinkering zone.

Ternary System CaO-Al_2O_3-SiO_2

The critical condition in the ternary system CaO-Al_2O_3-SiO_2, to which the composition of the white clinker portions correspond, comes within the range of portland cement through the reduction of the Al_2O_3 content to the CaO-SiO_2 requirements of the system, while this reaction has made no noticeable change in the ratio of $CaO:SiO_2$.

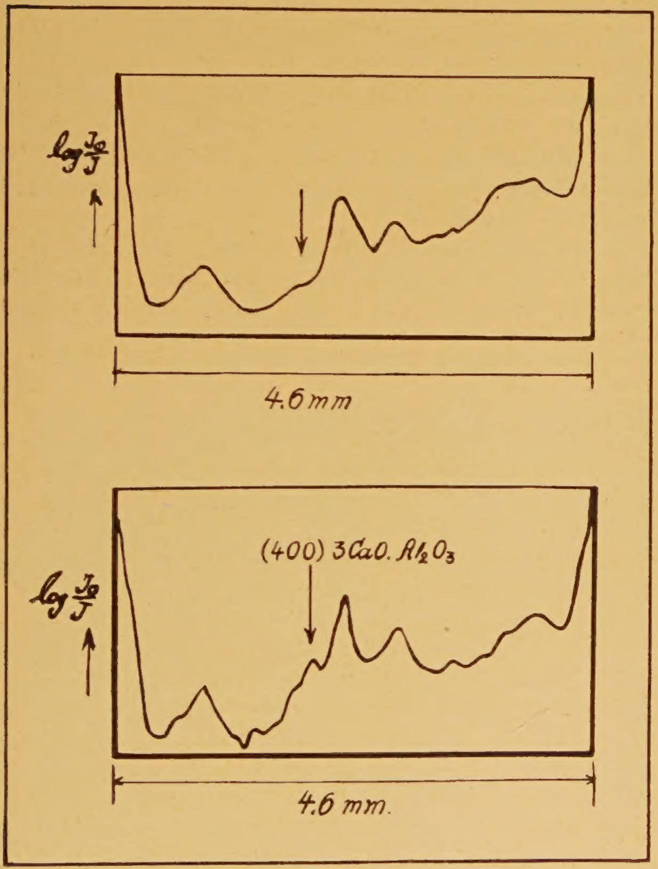


Figure 4. Cross-section of the micro-photograph of the light colored Alit clinker (upper diagram), and of the mechanical mixture of 96 per cent $3CaO.SiO_2$ and 4 per cent $3CaO.Al_2O_3$ (lower diagram)

Employee Suggestion Systems

Close contact of workers with particular operations of the business frequently enables them to supply ideas and suggestions of direct benefit to the company. To capitalize upon this practical experience and specialized knowledge, the employee suggestion system has been adopted with considerable success by a number of organizations. Many of these contributed to the compilation of data found in *Employees' Suggestion Systems*, a 24-page booklet published by the Policyholders Service Bureau of the Metropolitan Life Insurance Co.

This report discusses the methods used by representative industrial companies to obtain worthwhile suggestions from their personnel. The report is based on a study of the system of more than 100 organizations and describes the outstanding features of these plans.

Binary System CaO-B_2O_3 Studied by Bureau of Standards

An investigation to determine the possibility of producing a well-burned cement clinker at a relatively low temperature by the use of a small quantity of boric acid as a flux has been under way for some time at the U. S. Bureau of Standards (See *Cement Mill Edition* of CONCRETE, July, 1930, page 104), and good process is being made.

Preliminary thermal studies on cements and dicalcium silicate containing boric acid indicated that the boric acid caused a lowering of the refractive indices of the dicalcium silicate, and also that it caused a lowering of the temperature of the beta-alpha transition of this compound. A study of phase equilibria in part of the ternary system CaO-B_2O_3-SiO_2 is to be undertaken, and as a preliminary to this, the binary system CaO-B_2O_3 is being studied.

Four distinct compounds have been found, and their melting points determined approximately. The formulas and melting points are as follows: $CaO.2B_2O_3$, 990 deg. C.; $CaO.B_2O_3$, 1150 deg. C.; $2CaO.B_2O_3$, 1300 deg. C.; $3CaO.B_2O_3$, 1480 deg. C. These points represent maxima on the melting point curve. Optical data for these compounds have been obtained, and the phase diagram of this binary system is being worked out.

Plant Reopenings Continue During July and August

The Southern States Portland Cement Co., at Rockmart, Ga., resumed capacity operations early in August, after having been shut down for several weeks.

Indiana plants which reopened early in August include the Universal Atlas company, at partial capacity; the Milltown plant of the Louisville Cement Co., with 250 men—the greatest number employed in the past year, and the Lehigh plant at Mitchell, with approximately 200 men working on a shortened schedule. Six months' orders are on hand.

Another plant which resumed operation early in August was that of the Alpha company at La Salle, Ill., which had been shut down for a month and reopened to capacity operation.

The Southwestern plant at Victorville, Calif., reopened on August 1, after a six weeks' shutdown, and the Ohio plant at Osborn on July 11th. The Florence plant of the Colorado Portland Cement Co. also reopened in July, when a hundred men returned to work after having been idle for several months.

Low Power Consumption Attained in Whitehall's New Pulverizer

Takes Raw Material Direct From Hammer Mills—Power Requirements Only 9.2 Kwh. Per Ton of Rock—Performance Record

A NEW pulverizer installed early in 1932 at the Cementon (Penna.) plant of the Whitehall Cement Manufacturing Company pulverizes the raw material (cement rock) as received from the hammer mills. The hammer mill output is pulverized to the fineness required for burning, so that no further reduction is necessary before it enters the kilns. The cement company, in consequence, has been able to discontinue the use of its preliminary reduction mills, with their accessory elevators, feeders and conveyors, and several bins formerly used for the storage of partly reduced raw materials are no longer needed.

Good Performance Record

For a number of months this new pulverizer at the Whitehall plant has been in continuous operation in closed circuit with a mechanical air classifier. Up to July 1, 1932, it had pulverized an approximate total of 60,000 tons of cement rock. Capacities of approximately 35 tons per hour are obtained regularly. For short periods 39 tons per hour have been pulverized, the limitation being the capacity of the elevator.

The rock is delivered to the pulverizer from hammer mills, sized 1½ in. and under, and, after being finally pulverized, finenesses of 90 per cent through 200-mesh have been regularly achieved.

Low Power Requirements

The power required has averaged 9.3 kwh. per ton. When reduced to barrels on the basis of 600 lb. of cement rock to the barrel of clinker, the power consumption is 2.8 kwh. per barrel. The reasons for this low power consumption are apparent from a study of the construction of the pulverizer. First, it is observed that the power is expended in merely rolling a ball around a race, similar to a ball bearing. No heavy balls are required to be lifted. The second reason for low power consumption lies in the fact that scavenging of the pulverized material is complete and prompt, so that no cushioning effect is present to retard the efficiency of the grinding operation.

Obtain Performance Data From Test Runs

The space occupied by this mill is small, the arrangement is simple and the cost of the installation is low. Performance to the present time points also to low maintenance costs. The performance data given in the tabulation has been obtained from test runs at the plant, under various loads.

This new pulverizer is a further adaptation of the ball and grinding ring principle previously employed in this general type, in that it provides for positive grinding pressure and means for its control. The latter feature—the control of the grinding pressure—permits the product to be ground to any desired fineness even if the grinding elements have become worn. The fine material is quickly discharged from the mill, so as to eliminate the cushioning effect that otherwise would be present.

PERFORMANCE DATA ON NEW TYPE OF PULVERIZER

	Hours					
	1.00	1.00	1.25	1.00	1.00	1.00
Tons per hour	19.48	20.88	24.35	28.00	31.50	34.68
Barrels per hour[1]	64.9	69.6	81.2	93.3	105.0	115.6
Kwh. per ton, for mill	8.98	8.38	7.88	7.15	7.45	7.64
Kwh. per ton for elev. and sep.	2.01	1.95	1.40	1.59	1.49	1.53
Kwh. per ton for mill, elev. and sep.	10.99	10.33	9.28	8.74	8.94	9.17
Kwh. per bbl. for mill, elev. and sep.	3.30	3.10	2.78	2.62	2.68	2.75
Temp. of feed	133	131	126	126	136	138
Temp. of mill discharge	157	164	168	166	179	181
Temp. of tailings	151	159	164	161	177	176
Temp. of fines	139	150	158	156	169	169

[1] Based on 600 lb. of cement rock per bbl. of finished clinker.

The Grinding Elements

The grinding elements, which are located in a low position in the mill in order to minimize vibration, consist of three rows of large-diameter balls, together with three stationary and one rotating grinding ring. The rows of balls—two upper and one lower—are separated and propelled by the rotating grinding ring, which in turn is driven by means of a yoke fastened to the main driveshaft. The grinding pressure is applied to each upper row of balls by heavy steel springs that bear directly on the separate top grinding rings. The springs are held in place by guides and heavy steel screws.

Operation of Pulverizer

The operation of the pulverizer is quite simple, and may be followed to best advantage through reference to Figures 1 and 2. The raw material is fed from an overhead bin by means of a poidometer, directly into the pulverizer from a feed spout. It is deposited into the center of the mill and drops upon a table fastened to the rotating intermediate grinding ring. The tailings from the mechanical air classifier also drop on to this rotating table, where they become intimately mixed with the raw material.

Centrifugal action of the rotating table throws the material outward into the path of the inner row of grinding balls. The material then passes to the outer row, in which the second stage of pulverization takes place. From this second stage the material is discharged just outside the outer top row of grinding balls and passes through an adjustable ledge gap into the space below. Here it enters the path of the lower row of balls, where the third stage of pulverization takes place.

Upon leaving the lower row of grinding balls the pulverized material is discharged into an annular compartment which contains a number of sweeps. Due to the action of the sweeps, the material is rapidly discharged from the mill. It is then elevated to the mechanical air separator, which returns the oversize particles to the mill for further reduction.

Application of Power

Power is applied to the grinding elements through a compact double-reduction gear assembly. This assembly consists of a set of bevel gears for the first reduction, and a set of spur gears for the second reduction. Both gear shafts are supported by roller bearings.

The base of the pulverizer contains the entire driving mechanism, including the main shaft and thrust bearings, the gear assembly just described, and the force-feed oiling system. The main drive-shaft is supported by a self-aligning, heavy duty thrust bearing.

Accessible for Inspection

The opening for the feed and tailings spouts, and the steel housings that support the spring adjusting screws, are in the top cover plate of the grinding chamber. The grinding zone is made accessible for inspection or cleaning, either through a large hinged door in the casing or through a large covered manhole in the top cover plate.

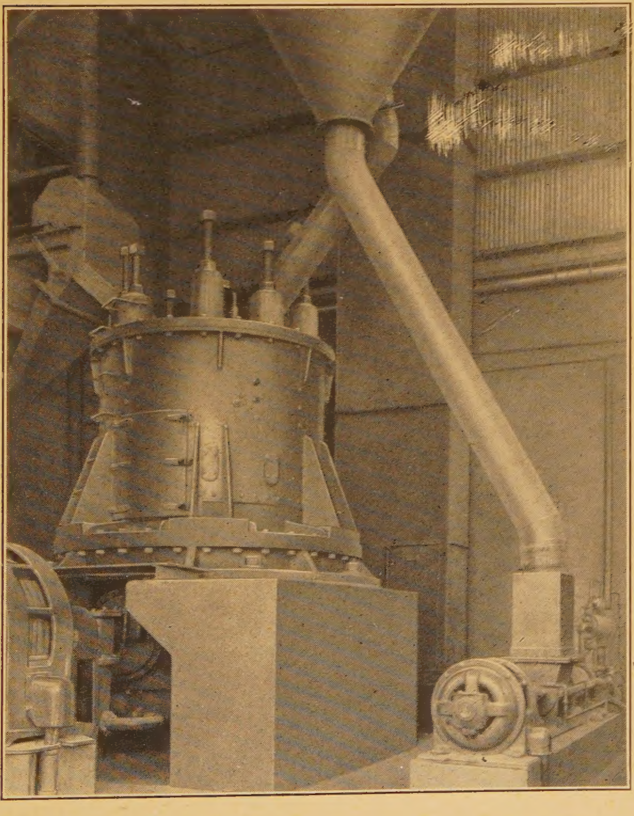


Figure 1. New pulverizer at Cementon plant of Whitehall Cement Manufacturing Co. operates with low power consumption

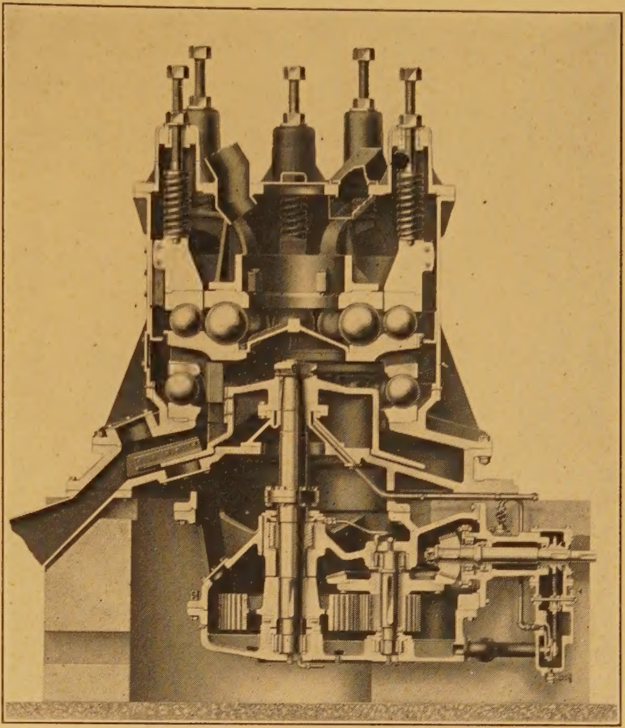


Figure 2. Cross-section showing component parts of new pulverizer installation

Acknowledgment

The new pulverizer at the Whitehall plant, here described, is known as the B. & W. Type B pulverizer, manufactured and installed by The Babcock & Wilcox Company, New York, N. Y.

Cement Marketing Company of India Sells All Cement

The Cement Marketing Company of India, Ltd., with headquarters offices in the Forbes Building, Home Street, Bombay, is the central marketing organization formed for the purpose of selling all portland cement produced in India.

This central organization regulates the output for each company, and sales are allotted on a quota basis. The organization at present sells eight brands. A detailed description of the method of operation appears in the February (1931) Cement Mill Edition of CONCRETE, pages 90-91.

500,000-Barrel Federal Order Placed with Marquette

An order for 500,000 bbl. of cement to be used in the construction of Mississippi waterway projects was placed with the Marquette Cement Manufacturing Co. late in July by the federal government.

The Oglesby, Ill., plant will supply the bulk of the order, and the Cape Girardeau, Mo., plant the balance.

Measurement of Particle Size With Accurate Air Analyzer

Fineness and Particle-Size Distribution of Commercial and Laboratory-Ground Cements — Description of Apparatus

By P. S. ROLLER
Associate Chemist, U. S. Bureau of Mines, Nonmetallic Minerals Experiment Station, New Brunswick, N. J.

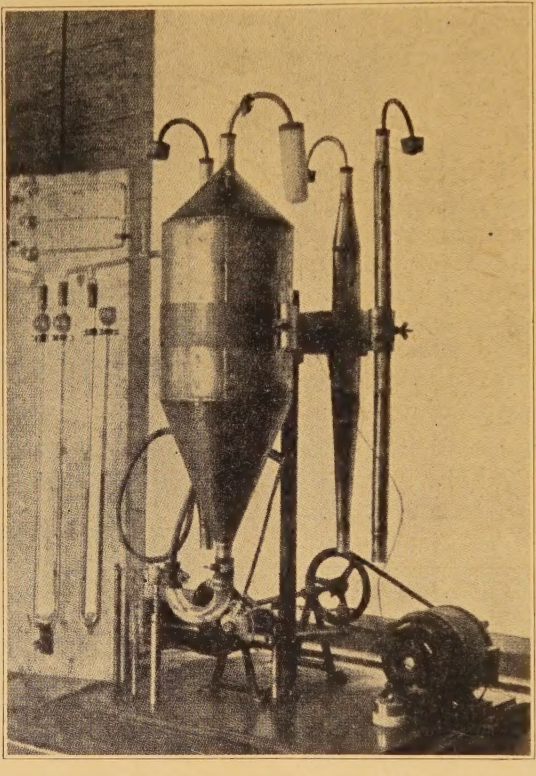


Figure 1. General view of apparatus and flowmeter

ANALYSIS into fractions 0 to 5, 5 to 10, 10 to 20, 20 to 40, 40 to 80, and 80 to 160 microns has been made of four brands of portland cement and of three laboratory-ground clinkers. It is found that the deviation of the recorded percentages by weight is nearly the same for all the fractions and averages close to plus or minus 0.2 per cent. The time required for fractionation varies from 62 minutes for the 0 to 5-micron to 11 minutes for the 40 to 80-micron fraction; for the six fractions the average total time of separation is less than three hours.

A rapid and efficacious method was developed for preparing a fine powder for microscopic examination by using a thin platinum wire and a drop of 0.25 per cent solution of saponin in 50 per cent alcohol.

For the size analysis of powders substantially passing through the No. 200-mesh sieve and composed of microscopic particles essentially 1 to 100 microns in size, a new type of air analyzer was previously described[1] and preliminary experimental results were recorded with two or three materials. A number of improvements have since been made in the design of the apparatus and in the manner of operation so as to facilitate the analysis and enhance the accuracy. In this paper the apparatus in its present improved form, and the method of operation are described; data on the analysis of several commercial portland cements and laboratory-ground clinkers are presented and interpreted.

Referring to Figures 1 and 2, four vertical settling tubes, *T*, are mounted on a cast-aluminum bracket that can be rotated about a central post so as to bring the tubes successively into position with reference to U-container *C*. Tubes *T* are made of No. 22 gauge stainless sheet steel highly polished on the inside. The cylindrical portion is in each case 1 ft. high, and respectively 9.0, 4.5, 2.25, and 1.125 in. in inside diameter. At the bottom the cylinders are tapered over the length of 10 in. to join with a short length of 1-in. stainless steel tubing. At the top, the tubes are similarly tapered over a length of 4 in. to join with a second short piece of 1-in. steel tubing. Gooseneck *G* is bent out of $^1/_2$-in. soft stainless steel tubing, polished on the inside. At the free end of the gooseneck is a machined rubber stopper on which fits a paper extraction thimble for filtering the fractions that are blown over, and which is large sized to minimize the back pressure. Both *T* and *G* are well grounded electrically.

The powder charge, about 25 cc., is placed in U-container *C*, made of heavy-walled pyrex tubing, 1 in. in inside diameter, bent on a radius, with its center located $^5/_8$ in. below the upper ends, $2^3/_8$ in. from the center of the tube. At the right, U-container *C* is closely coupled to the reduced end of tube *T* by means of pure gum rubber tubing and hose clamps. At the left, a 7-mm. air inlet tube of chromium-plated brass is bent so that the air jet impinges on the bottom center of U-container *C* at an angle of about 30 deg. with the horizontal. The inlet tube is threaded on the inside so as to receive any desired nozzle size.

The rubber-tipped hammerhead of hammer *H*, which causes U-container *C* to oscillate, makes about 300 taps a minute and is actuated by a motor-driven fiber cam that operates upon a fiber roller on the hammer shaft. An adjustable tension spring *S'* controls the force of the hammer blow. On the return oscillation of the U-con-

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[1] P. S. Roller, U. S. Bureau of Mines *Technical Paper No. 490*, p. 1 (1931).

Publication approved by the Director of the Bureau of Mines, U. S. Department of Commerce. Condensed from full report presented by the author at the 1932 annual meeting of the American Society for Testing Materials.

tainer lug L, which is fixed to the left end of C, strikes against abutment A. The latter is slotted to serve as a guide for L and is adjustable as to height. Arm R rests on L with a pressure that is determined by the strength of the adjustable tension spring S''. As illustrated in Figure 1, the constrained oscillation of U-container C causes the powder charge to move as a whole in a direction opposite to the air jet, while the particles constituting the charge rotate in a clockwise direction so that fresh portions are continuously exposed to the action of the air. Adjustment to correct operation is obtained by altering the tension of springs S' and S'' and adjusting the height of abutment A to bring U-container C to an approximately level position.

K in Figure 2 is a five-leaf spring steel tapper about $\frac{3}{4}$ in. wide and 1/32 in. thick that operates against the lower conical portion of the settling tubes T. This tapper profoundly affects the rate of separation, and also the uniformity of fractionation, by shaking down into container C particles which repose in the lower cone of the settling tubes.

The calibrated flowmeter consists of a bank of three capillaries, 1, 2, and 4 mm. in inside diameter, each of which is associated with a wide-bore stopcock. In using a capillary the stopcock is adjusted for minimum difference of level in the arms of the flowmeter. The whole apparatus may be placed in a soundproof chamber with hinged door, the motor being air-cooled or mounted externally.

The End-Point Rate of Separation

In the course of a separation, it is found that the particles that are blown over increase in size progressively upward for the 0 to 5 and 5 to 10-micron separations. Eventually the particle sizes are almost wholly in the upper boundary of the fraction. In prolonging the separation beyond this point, the particle sizes increase beyond the upper theoretical limit, reaching a maximum of about 1.5 times the theoretical maximum particle size.

The reason for the oversize with prolonged fractionation appears to lie in the fact that in viscous flow such as obtains in the settling tube, the velocity distribution across the tube is not uniform, but parabolic. From Poiseuille's law of flow, and also as experimentally observed,[2] the maximum velocity at the center of the settling tubes is twice the average velocity. This means that with prolonged fractionation the ultimate particles that are blown over are, as observed, $\sqrt{2}$ or 1.41 times the theoretical maximum calculated from Stokes' law.

In practice fractionation is completed at an end-point rate of separation at which the particles are in the upper theoretical boundary of the fraction. The end-point rate is determined empirically once for all by microscopic examination of the powder blown over and of the residue. For the same particle size separation, it appears to be proportional to the rate of air flow. In the present paper, the end-point rate of fractionation was found to be the same for all the fractions: 1.0 g. per hour. For a 100 per cent variation in the end-point rate—that is, from 1.0 to 2.0 or 0.5 g. per hour, the absolute percentage is altered by the amount of 1.21 per cent for the 0 to 5-micron fraction, and by the amount of only 0.73 per cent for the 5 to 10 and 10 to 20-micron fractions. The end-point rate can be ascertained well within the above rate variation of 100 per cent.

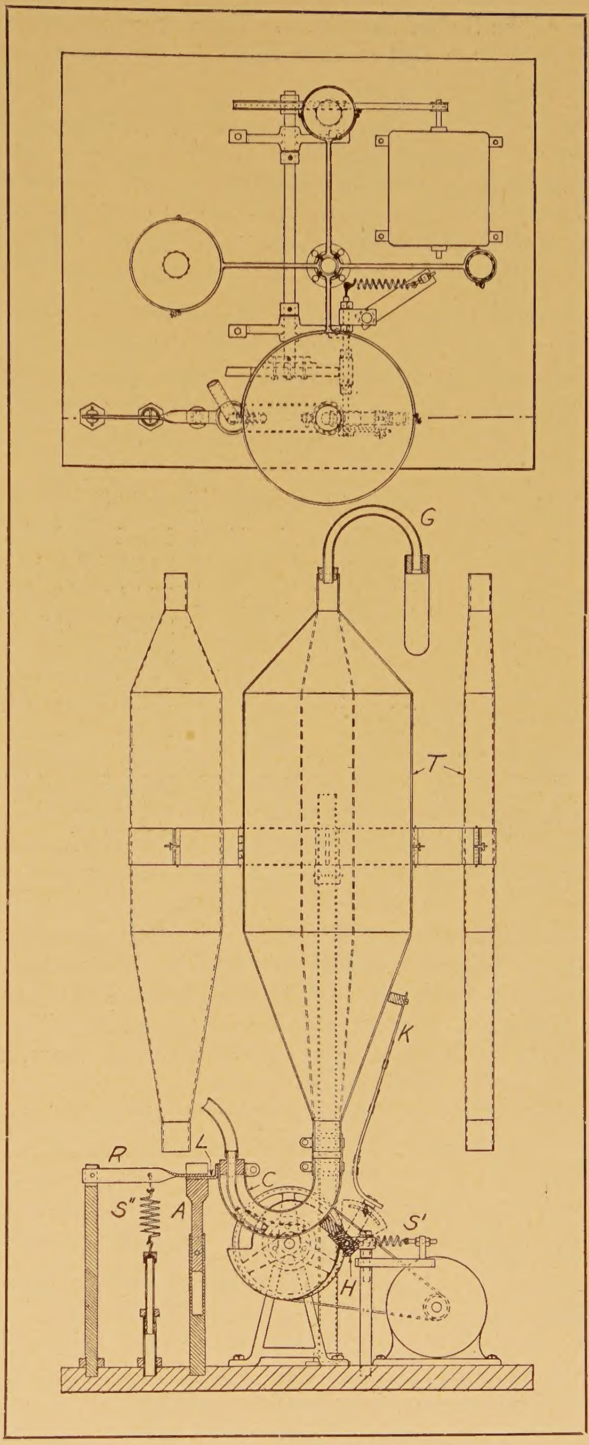

Figure 2. Air analyzer assembly

Results of Analysis of Portland Cement Powders

The percentage by weight in each of the fractions beginning 0 to 5-microns is shown in Table 1 for four brands of portland cement. In the last two rows of this table are given the surface mean diameter of the powder as a whole, and the dispersion. These quantities are calculated from the percentage by weight of each of the fractions,[3] taking the mean diameter of each fraction as the mean of the Stokes' law limits. The surface mean diameter varies from 10.4 to 10.9, while the dispersion varies from 13.2 to 15.7.

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[2] Stanton and Pannell, Nat. Physical Laboratory, Vol. 11, p. 293 (1914).

[3] P. S. Roller, U. S. Bureau of Mines *Technical Paper No. 490*, p. 1 (1931).

Particle-size analyses beginning 0 to 10 microns rather than 0 to 5 microns have been recorded in a few places in the literature. Gonell,[4] working with an air analyzer apparatus similar in construction to that of Pearson and Sligh,[5] obtained for three cements 29.0, 31.7, and 32.5 per cent by weight in the 0 to 10-micron range. These results are well above any of the percentages recorded in Table 1. With the Gonell apparatus, Kühl[6] obtained, for one cement, a value about 13 per cent less, or 18.2 per cent.

TABLE 1

Particle Size Distribution, Surface Mean Diameter, and Dispersion of Four Brands of Portland Cement

Fraction, Microns	——Particle Size Distribution—— Per Cent by Weight Brand I	Brand II	Brand III	Brand IV
0 to 5	12.06	12.64	12.15	11.58
5 to 10	14.47	13.78	14.21	16.05
10 to 20	16.67	17.55	18.71	21.84
20 to 40	23.73	25.44	27.89	30.84
40 to 80	27.26	25.23	24.06	17.55
80 to 160	5.81	5.36	2.98	2.14
Surface mean diam.	10.9	10.7	10.7	10.4
Dispersion	15.7	15.5	14.6	13.2

With a self-recording Wiegner sedimentation apparatus, Kühl and Tokune[7] obtained, for the 0 to 10-micron fraction of four cements, a trace, 14.4, 14.6, and 21.6 per cent —decidedly low results. By direct weighing of the sediment, Taylor[8] obtained, for the 0 to 10-micron range, the plausible value of 28 per cent.

Gonell[9] and Kühl[10] have found a relatively high ignition loss for the finest particle-size fractions. From a chemical analysis by Gonell[9] it appears that there is a concentration of alumina, and possibly also of tricalcium silicate, in the 0 to 10 as against the 10 to 20-micron fraction.

TABLE 2

Particle Size Distribution, Surface Mean Diameter, and Dispersion of Three Laboratory Ground Clinkers

Fraction, Microns	——Particle Size Distribution—— Per Cent by Weight Brand I	Brand II	Brand III
0 to 5	13.00	13.90	13.39
5 to 10	14.00	14.42	17.95
10 to 20	17.13	17.17	20.50
20 to 40	22.65	23.90	29.80
40 to 80	29.15	27.57	18.17
80 to 160	4.08	3.04	0.19
Surface mean diameter	10.6	10.2	9.6
Dispersion	15.4	14.7	12.1

It is often stated that clinkers ground in the laboratory cannot be made to simulate the particle-size distribution and fineness of clinkers ground in a mill. In Table 2 are given the results of the analysis of three clinkers that were ground in 50-lb. batches in a laboratory disk grinder and pebble mill. It is seen that the distribution of particle sizes among the different fractions, as well as the surface mean diameter, is reasonably the same as that for the commercial portland cements.

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[4] Gonell, *Zement*, Vol. 17, p. 256 (1928).

[5] Pearson and Sligh, U. S. Bureau of Standards *Technologic Paper No. 48* (1915).

[6] Kühl, *Zement*, Vol. 19, p. 604 (1930).

[7] Kühl and Tokune, *Zement*, Vol. 17, p. 256 (1928).

[8] Taylor, *Rock Products*, Vol. 35, No. 7, p. 46 (1932).

[9] Gonnell, *Zement*, Vol. 17, p. 256 (1928).

[10] Kühl, *Zement*, Vol. 19, p. 604 (1930).

Production of Masonry Cements

Output Last Year Is 31.3 Per Cent Below 1930 —Trend Similar to Portland Cement

The U. S. Bureau of Mines has reported a production of 1,241,803 bbl. of hydraulic cements other than portland cement, in 12 plants located in nine states of the United States, during the year 1931. This figure is 31.3 per cent below the production in 11 plants in 1930.

Cements coming under this classification include natural and puzzolan cements and masonry cements of the natural cement class. Production, shipments and stocks are given in the table for the period from 1925 to 1931, inclusive.

PRODUCTION OF NATURAL, PUZZOLAN AND MASONRY CEMENTS IN UNITED STATES

Year	Active Plants	Production, Barrels	Shipments, Barrels	Stock on Dec. 31, Barrels
1925	10	1,729,343	1,751,725	107,459
1926	11	2,104,891	2,031,851	181,928
1927	11	2,123,868	2,158,323	143,854
1928	11	2,210,404	2,213,645	137,357
1929	11	2,209,465	2,159,130	187,692
1930	11	1,792,083	1,787,016	202,416*
1931	12	1,241,803	1,226,850	217,369

*Figure revised from previous report.

Of the 12 plants represented in the figures for 1931, two are located in each of the states of New York, Alabama and Minnesota, and one each in Pennsylvania, Ohio, Indiana, Kentucky, Illinois and Kansas.

Marquette Improves Facilities for Barge Transportation

The Marquette Cement Manufacturing Co., during August, rebuilt its shipping facilities at the Peru terminal on the Illinois River, where this company ships a considerable tonnage of bulk cement in a fleet of four company-owned river barges. The capacity of the barges is 4,000 tons each.

Waterway transport of cement to southern points was inaugurated upon completion of the terminal.

Under the newly installed system the cement is elevated from freight cars to a level about 35 ft. above the tracks of the Burlington Railway. Carriers then convey the cement over a steel bridge to the barges at the dock.

The new loading equipment handles about 400 bbl. per hour. The contract for this new system was awarded to G. H. Stangel, Peru, Illinois, at a reported price of about $10,000.

EDITORIAL

When the First Dreadnaught Was Launched

SOME years ago when the British Navy launched the battleship Dreadnaught, great fleets of battleships in all navies were automatically rendered obsolete. Battleships of the older and smaller types could no longer be regarded as first-line fighting craft, for they were far out-classed by the newer dreadnaughts and super-dreadnaughts that made their appearance as fast as the naval powers were able to finance their construction. It was their tonnage that determined the relative first-line fighting power of rival navies.

Today there is a parallel situation in the cement industry—far more closely parallel than a number of cement manufacturers like to admit.

First we have the cement plants which, during the past few years, have been almost completely reconstructed with modern cost-reducing equipment and processes, in spite of all obstacles. These plants are now producing cement at little more than half the cost of the boom days of four or five years ago. They are the dreadnaughts and the super-dreadnaughts of the industry.

Many other plants, representing somewhere from 25 to 40 per cent of the so-called capacity of the cement industry, are still trying to operate with equipment that is completely out-classed by the reconstructed plants. Costs in these obsolete mills have been reduced but little beyond the reductions attained through lower wages and salaries. These are the obsolete battleships of the cement industry.

Unpleasant as the truth may seem, the plants in this second group can not, in their present state, be rightfully regarded as a part of the total capacity. In due time this fact will be recognized.

In the meantime some of the obsolete units may be modernized; but others, like the old-line battleships, may have to be scrapped. It is a ruthless way to reduce manufacturing capacity, but it is the way of industry.

The Trade Acceptance Plan

IN furtherance of a concerted plan initiated by leading American industrialists to stimulate interest in the use of trade acceptances as a means for the expansion of the volume of credit available to industry, Magnus W. Alexander, president of the National Industrial Conference Board, has sent a letter to industrial concerns throughout the country, urging immediate and serious consideration and adoption of the trade acceptance plan.

One of the prime purposes of the letter is to secure an expression of intention from the concerns addressed. Mr. Alexander believes that a great stimulus to business in all parts of the country may be expected to result from an expression of intention on the part of business concerns generally to put their buying and selling transactions, as far as practicable for their respective businesses, on the trade acceptance basis. There would thus be applied a ready means of opening the vast credit facilities of the banks to business concerns, both large and small, wherever situated. The use of trade acceptances would have the effect of speeding up the turnover, increasing the net return, and improving the credit standing of business concerns, since collections would be expedited by the substitution of readily negotiable paper for slow open-book accounts.

The manner in which the trade acceptance plan serves as an aid to sales under present conditions is well illustrated in a case that recently came to hand. Early in August a salesman who represents a steel products manufacturing concern called on a customer in a down-state Illinois city. This customer uses rivets, and for almost a year he had been buying on a hand-to-mouth basis, in 5,000-lb. orders.

On this trip the salesman was armed with this new sales aid—his company had inaugurated the use of trade acceptances. The purchasing agent of the down-state manufacturer was about to order another 5,000-lb. lot, but after the salesman explained the operation of the trade acceptance plan the order was promptly changed to a carload lot. The larger order saved money for both the seller and the buyer.

Quite naturally, the use of the trade acceptance plan should be restricted to current transactions, and not extended to past-due accounts. Due caution must be exercised, and the credit position of the customer must be given the usual consideration.

It is believed, however, that lack of familiarity with the trade acceptance method is the principal obstacle in the way of a general adoption of this credit facility—a facility that is in general use in the industrial countries of Europe.

Cement manufacturing executives who have not examined the trade acceptance method might well make a study of its application to their own sales departments.

Investigate Minor Components of Portland Cement

Brownmiller and Bogue Report Results of Experiments by Method of Phase Equilibria — Soda One of Important Minor Constituents of Cement

A PART of the system $CaO\text{-}Na_2O\text{-}Al_2O_3$, in the region that is low in Na_2O, has been investigated by L. T. Brownmiller and R. H. Bogue and reported in full in the February (1932) issue of the Bureau of Standards Journal of Research, published by the U. S. Department of Commerce.

Phase Equilibria Method

The method of phase equilibria was employed. The stability fields, boundary curves and invariant points are defined. Optical and X-ray data are given in the full report, and ternary diagrams are introduced to indicate the composition and temperature relations and the course of crystallization in the system.

The studies reported are a continuation of a series begun several years ago to determine the constitution of portland cement clinker and the part played by each of the compounds in the manufacture and utilization of that product. Today those studies are fairly complete for the principal constituents of portland cement, namely, for CaO, SiO_2, Al_2O_3, Fe_2O_3, and MgO, and from them the modern ideas on the constitution of cement have been evolved.*

Many Minor Components in Cement

Besides these components, there are many others occurring in small amounts in cements. Of the minor components, soda is one of the more important, since it is common to practically all cements. Therefore a continuation of those studies has been made to determine the combinations which soda is capable of forming with the other constituents of the cement.

The system $CaO\text{-}Na_2O\text{-}Al_2O_3$ has now been examined. This system, however, was not explored completely. Not only would special methods have to be adopted to solve it entirely, but, in cements, the concentration of soda is small; hence, the studies in the system could be confined to compositions low in Na_2O. Apparently only one compound of CaO and Al_2O_3, $3CaO.Al_2O_3$, occurs in normal portland cements; accordingly that region of the diagram $CaO\text{-}Na_2O\text{-}Al_2O_3$ in which $3CaO.Al_2O_3$ occurs is the field of greatest importance. Nevertheless, because of the complexity of the system, other portions of the diagram had to be investigated to understand fully the relations in that region.

Summary

Two ternary compounds were found in the system, having the compositions: $3CaO.2Na_2O.5Al_2O_3$ and $8CaO.Na_2O.3Al_2O_3$.

The stability fields of the phases in the system have been defined, the boundary curves indicated and the invariant points located. The compositions and melting points of the compounds and of the invariant points are summarized in tables. The optical properties of the ternary compounds and of $Na_2O.Al_2O_3$ and βAl_2O_3 are also given in tables. The interplanar spacings of the X-ray diffraction patterns are listed for the ternary compounds and for the binary compounds which have not previously been reported. Diagrams are presented which indicate the stability fields, temperature relations, and course of crystallization in the system.

Acknowledgments

The authors gratefully acknowledge their indebtedness to Dr. W. C. Hansen, formerly of this staff, for his contributions to this study. The investigation was begun by Dr. Hansen and brought by him to partial completion in the region of the compound $3CaO.2Na_2O.5Al_2O_3$. Both for this important contribution and continued interest and advice in the final solution of the system the authors take pleasure in giving full recognition and thanks.

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*Brownmiller and Bogue, *Am. J. Sci.*, vol. 20, p. 241; 1930. Also *B. S. Jour. Research*, vol. 5, p. 813; 1930.

Titration in Sugar Solution as Test of Durability

During 1931 the U. S. Bureau of Standards conducted an investigation of the value of a suggested method for predicting the durability of cement by means of a hydrochloric acid titration of the cement in a sugar solution. The test was applied to a large number of cements in an attempt to discover any existing correlation between the titration values received and the actual resistance of the various cements to the action of sodium sulphate. In general, the cements having the higher "indices," that is, higher titration values, were found to be less resistant to the action of the sulphate solution. The correlation, however, was rather poor.

Hazards of Dust Explosions to Be Shown

Dust explosion demonstrations will be staged as a part of the twenty-first annual congress of the National Safety Council, to be held at Washington, D. C., October 3 to 7.

The demonstration, planned to show the hazards of dust, will take place in a miniature factory at the Government Testing Station, in Arlington, Va., just over the line from Washington.

Sessions will be held at the Wardman Park and the Shoreham Hotels. The initial session of the Cement Section program will take place on the morning of October 4.

Rapid Determination of Silica, Alumina and Iron Oxide

Control of Setting Time by Electric Current and Determining Constituents of Hardened Concrete Also Discussed Before Congress of Industrial Chemistry

IN the seventh section of the Eleventh Congress of Industrial Chemistry held recently in Paris, certain reports were presented, of which a brief summary is given here, because of their interest to readers.

Mr. Baire, director of the laboratory of La Compagnie Ciments Francais de Boulogne-sur-Mer, who on several occasions has contributed to our publication, presented the first two of the following reports:

(1) Rapid determination of silica, alumina and iron oxide in raw mixtures for the manufacture of cement.

(2) Control of the setting of cement by means of an electric current.

(3) Determination of the constituents of hydraulic concretes after completion of the work.

Concerning the first of the foregoing reports, it is important, in the manufacture of portland cement, that the proportions of the ingredients in argillaceous materials remain constant.

It is also necessary that there are no great variations in the relative proportions between silica, alumina and iron oxide. When the quarry output is very irregular in composition, a method which permits the determination of the proportions of these elements with rapidity and with sufficient accuracy will be found useful.

The Procedure

The method which we propose is a modification of the acetate method. It is operated in the following manner:

The raw mixture of limestone and argillaceous material which is to be analyzed is previously decarbonated in a complete manner, after which it is cooled and pulverized. Two samples of 1 gr. each of the material thus treated are measured out.

The first sample is used for the determination of the silica and of the total peroxides. The powdery sample is dampened with a little water and is treated with crystallizable acetic acid. This is heated rapidly in a sand bath. It is then removed from the fire, hot water is added, followed by the addition of dilute nitric acid until the reddish color has disappeared. It is then brought to the point of violent boiling for a period of five minutes. The sample is then filtered, washed, dried and ignited, and weighed. Thus the total silica (SiO_2) is obtained.

To the filtrate pure hydrochloric acid is added, and then it is brought to rapid boiling for a period of ten minutes, then neutralized by a slight excess of ammonia, through which the peroxides are precipitated.

The second sample of the decarbonated mixture is used for the determination of iron. The sample is treated with dilute sulphuric acid, after which it is held almost at the boiling point for a period of one hour, in a sand bath. It is then carefully diluted with water, and agitated. It is then treated with zinc, and after being decanted it is titrated with permanganate.

The alumina is determined by difference.

This method permits the determination of silica, alumina and iron oxide in two hours, and with sufficient accuracy for the practical requirements of industry.

Control of Setting Time by Electric Current

When a neat cement paste is mixed and then subjected to the action of an electric current, it is found to possess a certain conductibility which can be measured by means of an amperometer.

When the setting action of cement begins, the conductibility ceases and the indicator of the amperometer remains at zero.

It appears, therefore, that the indications of the Vicat needle can be controlled by means of an electric current.

Unfortunately, every current produces a rapid and intense heating of the cement paste, and this naturally causes an acceleration in the setting time. In order to avoid this disadvantage to the greatest possible extent, experimenters have learned to pass the current intermittently, a few seconds at a time and at intervals of about the same time. Besides, they employ a current of low voltage and a highly sensitive amperometer.

However, a small amount of heating is always produced by the current. This repeated heating influences the setting time. The setting times registered by the electric procedure are always shorter than under ordinary conditions.

It remains to be determined whether the electric current, besides raising the temperature, also favors the formation of salts which affect the hardness of concrete. With this reservation, the method described permits very useful applications in some cases.

Determination of the Constituents of Hardened Concrete

Mr. Malette, who, with Mr. Baire, attended the congress held in Barcelona two years ago, at which time he presented some valuable reports, also contributed to the congress held in Paris. Following is a summary of his report on the determination of the constituents of hardened concrete.

He demonstrates that in spite of the difficulties of the problem, it can be solved by means of chemical analysis,

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Translated from *Cemento* (Barcelona), December, 1931.

thereby making known the proportion of hydraulic ingredients which enter into the concrete.

The author gives the reason why, in his opinion, it is preferable, in a majority of cases, to determine the soluble silica. This was the element employed for this purpose in the investigation reported. The procedure indicated in the report is of great interest because of the preponderating importance of this ingredient of concrete.

Examine Thermal Decomposition of Tricalcium Silicate

Tendency Shown Toward Dissociation Into Dicalcium Silicate and Lime at Certain Temperatures

An examination into the thermal decomposition of tricalcium silicate, in the course of a series of tests conducted by the U. S. Bureau of Standards, has resulted in the establishment of several significant facts.

The behavior of tricalcium silicate at temperatures between 1000 and 1300 deg. C. was studied by determining the amount of free lime present in samples which had been held at various temperatures in this range for definite periods of time. The following facts were established:

1. Tricalcium silicate tends to dissociate into dicalcium silicate and lime when heated to temperatures between 1000 and 1300 deg. C.

2. The reaction takes place most rapidly at about 1175 deg. The samples studied liberated about 15 per cent CaO on being heated for one day at this temperature.

3. The presence of either of the products of the reaction (dicalcium silicate and free lime) appears to be necessary to start the reaction.

4. Tricalcium silicate which has been exposed to the air for some time breaks down much more readily than the freshly burned material, probably because the moisture in the air reacts with the silicate, liberating lime, which then catalyzes the decomposition.

5. The presence of gypsum also facilitates the decomposition of tricalcium silicate, probably because the gypsum breaks down on heating, liberating lime.

Eastern Cement Prices Make Advance

The East-sweeping wave of increases in cement prices reached Atlantic Coast states late in July. Lehigh Portland was one of the first to raise quotations from 19 to 29 cents a barrel. The increases, the first in 2½ years, were put into effect also by International, Alpha, and Penn-Dixie.

Anticipating a heavily increased demand through an enlarged program of road construction, three Milwaukee companies late in July announced an increase of from 54 to 60 cents a barrel, or 30 per cent.

~ PERSONALS ~

Dan R. Long has been appointed to the position of district sales manager by the Pennsylvania-Dixie Cement Corp., in charge of activities in metropolitan and suburban

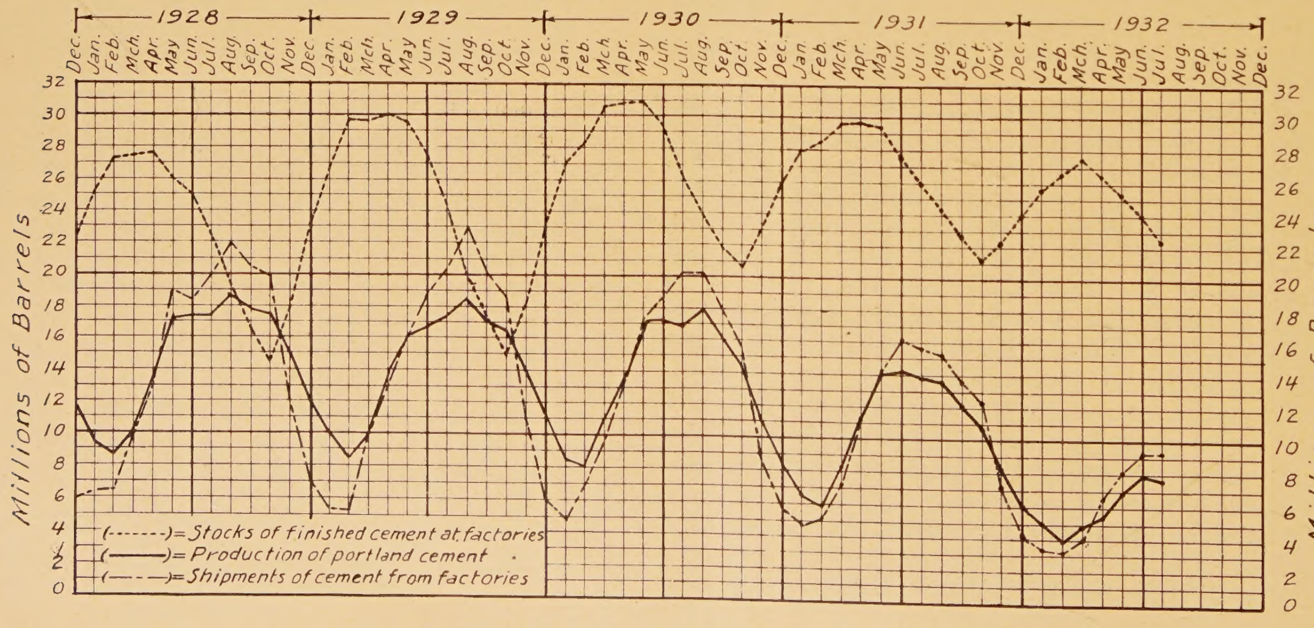
Cement Statistics for July

Relation of Production to Capacity

	The Month	Twelve Months
July, 1932	33.4	34.2
July, 1931	62.0	53.8
June, 1932	35.7	36.5
May, 1932	30.2	38.9
April, 1932	24.8	41.7

Production, Shipments and Stocks of Finished Portland Cement

	1931	1932
Production, July	13,899,000	7,659,000
Shipments, July	15,545,000	9,215,000
Stocks at end of month	25,934,000	22,479,000
Production for year to date	74,032,000	41,815,000
Shipments for year to date	73,964,000	43,249,000



New York, northern New Jersey, and western Connecticut, with headquarters in the Lincoln Building, 60 East 42nd Street, New York.

Mr. Long's experience in marketing cement dates back to 1916, at which time he joined the sales force of the Atlas Portland Cement Co. in the Minneapolis district. He left the Atlas company to join the Penn-Dixie organization a few years ago.

Frank Petry, metropolitan sales manager for the Pennsylvania-Dixie Cement Corp., died suddenly from a heart attack at Hackensack, N. J., August 8. He was forty-six years of age.

Mr. Petry had been connected with the cement industry for the past twenty-one years.

L. E. Smith has been transferred by the Medusa Portland Cement Co. to the superintendency of the Dixon, Ill., plant. He formerly held the same position at the Newaygo, Mich., plant.

Mill Equipment

Jeffrey Using Manganoid and Omico Metals in Parts Manufacture

Omico "Long Life" bolts for cement plant service are now being produced by the Jeffrey Manufacturing Co., Columbus, Ohio.

Omico metal is said to insure greater tensile strength, elongation and hardness than ordinary wrought iron. It has a Brinnell hardness of approximately 200 as compared with wrought iron, which generally ranges from 80 to 100. Bolts are guaranteed to give from 20 to 25 per cent longer life from an abrasion standpoint.

Seamless conveyor buckets made of Omico metal are also available.

Grinding balls, liners and plates of Manganoid metal are also being manufactured by the Jeffrey company. The metal has found extensive use in Jeffrey pulverizers and crushers and is said to be of very high Brinnell.

Searchlight Stops Thievery in Trinity Cement Plant

Installation of a police boat type of searchlight at the plant of the Trinity Portland Cement Co. caused the cessation recently of a series of nocturnal thefts of valuable company property. The night watchman had been frustrated in his attempts to prevent the stealing by threats from the thieves.

General Electric engineers suggested the use of a searchlight. A searchlight of the type used on police boats was installed on top of a small building situated on a hill, thus commanding a view of all sections of the property. The light is controlled from inside the building, and can be turned in any direction.

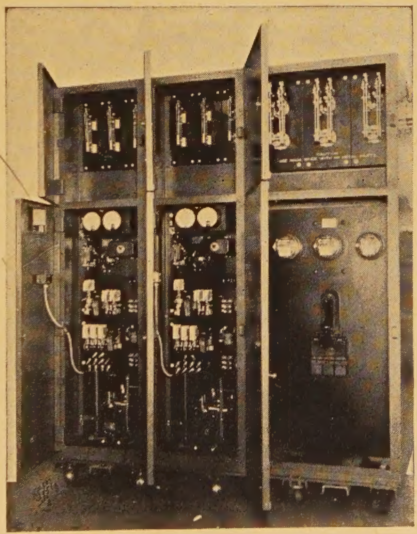
The watchman now stays in the tower all night, punching a clock at regular intervals. He readily spots the beam, by the feel of the handle, with the light off, on any point at the quarry he wishes to check. He then turns the light on with the beam already directed. Thus, if anybody were at the point in question, he would be taken unawares. A rifle completes the watchman's equipment.

Nothing has been lost from the quarry since the installation of the light.

Westinghouse Encloses Motor Against Dust

Protection against dust, by being entirely enclosed in cubicles, is afforded a synchronous motor starter recently built and shipped from the East Pittsburgh works of the Westinghouse Electric and Mfg. Co.

The unit comprises three compartments. One contains an incoming line circuit breaker with disconnect switches, while each of the others houses an individual synchronous motor starter with an electrically operated breaker and an individual disconnect switch.



Each compartment is provided with a lock to prevent unauthorized attention, and no operation can take place from without the cubicle except starting and stopping the motors, which is accomplished from a remote push-button station. The individual motor generator exciters are controlled from the same push-button that starts the synchronous motor. All compartments are open in the accompanying illustration.

New Cutting Attachment for Welding Torch

The Smith Welding Equipment Corp., Minneapolis, Minn., has placed on the market a new cutting assembly, or attachment, for a welding torch called the "Money Saver" cutting assembly.

In designing this cutting assembly the engineering department eliminated every customary feature usually considered necessary, such as levers for the cutting oxygen and adjustable unions to change the position of the assembly in the handle, etc., and substituted valves.

The cutting oxygen valve is a triple thread, screw valve with knurled thumb wheel so arranged that it can be quickly opened and closed with the thumb. The valve forging has been reduced to the simplest possible design, the cutting tip automatically evening up the flames.

Miniature Switchboard Equipment Controls Power Apparatus

A miniature switchboard supplied by the General Electric Co. controls apparatus in the newly modernized hydro-electric station of the Appalachian Electric Power Co., near Lynchburg, Va. The station consists of five 3125-kva. 4000-volt generators, one 15,000-kva. 4000 Y/13,200-volt and one 10,000-kva. 13,200/132,000-volt transformer bank, five 13,200-volt 150/300 ampere feeders and two 132-kv. circuits.

The control board is constructed of sheet steel, with an ebony asbestos section for mounting the control switches and lamps. Space is available for a possible 18 control positions. The control switch and lamp sections are placed directly below the respective instruments for the circuits to be controlled. The operator controls all generators, transformers, and circuit switches without leaving his seat at the board. A complete set of miniature instruments is also provided to indicate power output and other necessary information. When a remote control unit is opened by a protective device, or from any source other than the operator's signal, a lamp lights and an alarm bell rings. The action of the remote control system is instantaneous, as each device is controlled over its own individual wires.

Anticipating a steady industrial growth at Lynchburg, the step-up transformers in the outdoor substation have been provided with an extra winding so as to permit the use of 33,000 volts for loop transmission at a later date. Ample space is allowed on the switchboard for this development.

With the Manufacturers

Industrial Literature

Rubber Goods Data

Engineering information and data never before published is said to be contained in a condensed catalog giving a simplified, comprehensive line-up of principal industrial rubber goods and just published by the *B. F. Goodrich Rubber Co.*, Akron, Ohio.

It is titled *Engineering Data, Industrial Rubber Goods*, and is available to those who request it.

Among the condensed engineering data, is Table No. 1, Page 3, on rubber transmission belting, giving at a glance horsepower capacities, minimum pulley diameters, leather belt equivalents and list prices on all commonly used sizes of transmission belts.

With the use of a table given on conveyor belts it is possible to figure required sizes and plies of a belt without using a formula.

Chromium Steel Tubes and Pipe

Four to Six Per Cent Chromium Steel Tubes and Pipe is the title of a new 16-page bulletin issued by the *Babcock & Wilcox Tube Company*.

This publication presents, in technical style, the advantages of four to six per cent chromium steel tubes and pipe for refinery and other services. Recommended uses are prescribed, and complete chemical and physical characteristics given in detail. Data are also given on four to six per cent chromium steel with tungsten and molybdenum.

Engineers and operators may secure copies of this bulletin by addressing the Babcock & Wilcox Tube Company, Beaver Falls, Pa.

Drill and Valve Publications

The *Worthington Pump & Machinery Corp.*, Harrison, N. J., has recently issued a half-dozen catalogs on its various types of equipment.

Included are *Bulletin W-120-S1A*, describing hand-held drills for light, medium and heavy duty, and *D-445-S2*, on hydraulic by-pass and check valves, showing cross-section views and listing sizes and capacities.

Clark Cost Cutters

In the space of a catalog 2½ by 4½ in. but containing 48 pages, the *Clark Tructractor Co.*, Battle Creek, Mich., has assembled descriptions and illustrations of most of its types of material handling vehicles. Their use to cut costs is emphasized.

Screen Bulletin

Bulletin No. 123 issued recently by the *Gifford-Wood Co.*, Hudson, N. Y., presents interesting information on the Mitchell electric vibrating screen.

The principle, simplicity and use of the equipment are stressed.

Weighing Costs

A cost analysis of hand and automatic weighing has been made by the *Streeter-Amet Co.*, Chicago, and is published in folder form, available upon request.

The firm manufactures Streeter-Amet automatic weight-recording attachments. Its equipment is claimed to save money when the operating cost is as low as $8 an hour and with a weighing volume as slight as ten cars a day.

Fafnir Dragon

The August issue of *The Dragon*, publication of the *Fafnir Bearing Co.*, New Britain, Conn., includes, among other subjects, the elimination of shaft shoulders through the use of wide inner ring type ball bearing, a new felt seal, and band saw guide wheels.

FIELD ACTIVITIES

Babcock & Wilcox Tube Distributor

A. M. Castle & Co. has been appointed the distributor of the *Babcock & Wilcox Tube Co.'s* products in the Chicago and Pacific Coast territories.

This company is the only distributor representing the Babcock & Wilcox Tube Co. in the Chicago district and is the exclusive distributor and sales agent for B & W tubes on the Pacific Coast, where A. M. Castle & Co. maintains warehouses at San Francisco, Los Angeles, and Seattle; with the exception that C. C. Moore & Co., agents for the Babcock & Wilcox Co., will continue to sell and service retubing jobs for B & W and Stirling boilers.

Experimental Activities Centralized

The centralization of all divisions of Hercules experiment and research at the new Experiment Station, near Wilmington, is announced by *Hercules Powder Company*. The changes will bring all experiment activities in closer touch with the company's main offices and will enable more complete contact with industries using Hercules products, it is stated by *Harry E. Kaiser*, director of the Hercules Experiment Station.

The Kenvil, New Jersey, branch of the experiment station will cease to function as a separate organization and the Kenvil facilities will be taken over by the company's explosives department and placed under the jurisdiction of the adjacent Kenvil plant. R. S. Hancock, assistant director in charge of explosives research, will be transferred to the main laboratories near Wilmington. The executive offices of the station will hereafter be at the Hercules home office, Delaware Trust Building, Wilmington.

With the completion of the reorganization, all general research will be centered at Wilmington and all development work of an operating or sales nature will be carried on at the plants making the product involved. The new Hercules experiment station, which was completed and put in operation last year, is located on a 300-acre tract of land about five miles west of Wilmington.